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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Yoshihisa Iba

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12/14/2005

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EXAMINER

NGUYEN, HA T

ART UNIT

PAPER NUMBER

2812

DATE MAILED: 12/14/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/784,821

Applicant(s)

IBA, YOSHIHISA

Examiner

Ha T. Nguyen

Art Unit

2812

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 9-27-5.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) 1 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 2-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

1. Applicant's Amendment and Response to the Office Action mailed 6-29-5 has been entered and made of record.

Claim Objections

1a. Claims 14-16 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claims 14-16 recite limitation already included in the independent claims 2, 8, and 12, upon which they respectively depend.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(a) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 2-7, 12-14, 16, 17, 19, 20, 22, 23, and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants' admitted prior art (hereinafter "APA") in view of Tonegawa et al. (USPAPN 2003/0155657 A1, hereinafter "Tonegawa").

Referring to Figs. 8A-8D and related text, APA discloses [Re claims 2 and 14] a method of fabricating a semiconductor device, comprising the steps of: forming an SiC barrier film 103 over an interconnection 102; forming an interlayer dielectric film containing Si, C, and O 104-105 over the SiC barrier film, the examiner interpreted that at least at the interfaces of layer 105 with silica and SiO₂, layers of Si, C, O are formed, wherein the interlayer dielectric film is a low dielectric film; forming a hole reaching the SiC barrier film in the interlayer dielectric film (see Fig. 8C); etching the SiC barrier film to allow the hole to reach the interconnection; and burying a conductive material in the hole (See pars. [0009]-[0010]). But it fails to disclose expressly performing plasma processing using a hydrogen-containing gas on side surfaces of the interlayer dielectric film, the side surfaces being exposed to the hole; [Re claim 3] wherein a gas containing at least H₂ gas is used as the hydrogen-containing gas; [Re claim 4] wherein a gas containing at least NH₃ gas is used as the hydrogen-containing gas; [Re claim 5] wherein the side surfaces of the interlayer dielectric film is modified by the plasma processing, thereby increasing a selectivity to the SiC barrier film; [Re claim 7] wherein the plasma processing is performed by supplying a gas containing N₂ gas and not substantially containing oxygen into a processing chamber in addition to the hydrogen-containing gas. However, the missing limitations are well known in the art because Tonegawa discloses these features (See pars. [0067]-[0068]). A person of ordinary skill is motivated to modify APA with Tonegawa to obtain better adhesion.

[Re claim 6] Tonegawa also discloses wherein a thickness of the side surfaces to be modified by the plasma processing is not more than 10 nm (see Table 5).

[Re claims 12 and 16] The combined teaching of APA and Tonegawa discloses a method of fabricating a semiconductor device, comprising the steps of: forming an SiC barrier film over an interconnection; forming an interlayer dielectric film containing Si and O over the SiC barrier film, wherein the interlayer dielectric film is a low dielectric film; forming a hole reaching the SiC barrier film in the interlayer dielectric film; performing plasma processing on side surfaces of the interlayer dielectric film, the side surfaces being exposed to the hole thereby inherently giving impact to the side surfaces of the interlayer dielectric film to harden the side surfaces; etching the SiC barrier film to allow the hole to reach the inter -connection; and burying a conductive material in the hole, as shown above.

Art Unit: 2812

[Re claim 13] Tonegawa also discloses wherein the plasma processing is performed by supplying a gas containing at least He gas into a processing chamber (See par. 0068]).

[Re claims 17 and 19] wherein a film selected from the group consisting of a porous silica film, SiOC film, porous SiOC film, SiOCN film, and porous SiOCN film is formed as the interlayer dielectric film (see Fig. 8A and corresponding text)].

[Re claims 20 and 22] Tonegawa also discloses wherein a single damascene method is used, and the hole is formed as a wiring trench; [Re claims 23 and 25] wherein a dual damascene method is used, and the hole is formed as a wiring trench and as a via hole (see Figs. 6A-9C).

Therefore, at the time of the invention, it would have been obvious to combine APA with Tonegawa to obtain the invention as specified in claims 2-7, 12-14, 16, 17, 19, 20, 22, 23, and 25.

4. Claims 8-11, 15, 18, 21, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Tonegawa, as applied above, and further in view of Ryuzaki et al. (USPN 6777325, hereinafter "Ryuzaki").

The combined teaching of APA and Tonegawa discloses substantially the limitations of claims 8-11, 15, 18, 21, and 24, as shown above.

But it fails to disclose expressly [Re claim 8] the plasma processing forming an organic film on the side surfaces of the interlayer dielectric film; [Re claim 9] wherein the plasma processing is performed by supplying a gas containing carbon and fluorine into a processing chamber; [Re claim 10] the step of forming an SiO₂ film on the interlayer dielectric film, between the step of forming the interlayer dielectric film and the step of forming the hole in the interlayer dielectric film, wherein the hole is also formed in the SiO₂ film in the step of forming the hole in the interlayer dielectric film, and the plasma processing is performed such that no organic film is formed over the SiO₂ film; [Re claim 11] wherein C₄F₆ gas is used in the step of performing the plasma processing and in the step of etching the SiC barrier film.

However, the missing limitations are well known in the art because Ryuzaki discloses the use of CF₄, CHF₃, C₂F₆, C₄F₈ instead of conventional plasma treatment to achieve smaller degradation in dielectric constant (See col. 8, lines 24-36). In the combined teaching of APA, Tonegawa, and Ryuzaki, all the claimed limitations are met.

A person of ordinary skill is motivated to modify APA and Tonegawa with Ryuzaki to obtain less reduction in dielectric constant.

Therefore, at the time of the invention, it would have been obvious to combine APA and Tonegawa with Ryuzaki to obtain the invention as specified in claims 8-11, 15, 18, 21, and 24.

Response to Amendment

5. Applicant's arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicant argues that the combined teaching of APA and Tonegawa does not teach the claimed invention because Tonegawa does not teach the plasma treatment on a side surface of the interlayer dielectric film that is exposed to the hole. The examiner disagreed, Tonegawa plasma treatment is performed on all exposed surfaces including the one exposed to the hole (see Figs 5A-5C).

Applicant also argues that the combined teaching of APA and Tonegawa does not recognize either the problem or the solution. In other words Applicant argues that Tonegawa teaches a different reason for plasma treating than that of the instant invention. However the rationale for modifying a reference different from the applicant's is permissible in establishing obviousness (see MPEP 2144 and cited cases therein). In the instant case, one would modify APA to obtain better adhesion as taught by Tonegawa.

Therefore, the combined teaching of APA and Tonegawa does teach or make obvious all the limitations of the rejected claims 2-25.

Conclusion

6. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for response to this final action is set to expire THREE MONTHS from the date of this action. In the event a first response is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

Art Unit: 2812

CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event will the statutory period for response expire later than SIX MONTHS from the date of this final action.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha T. Nguyen whose telephone number is (571) 272-1678. The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt, can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Ha Nguyen
Primary Examiner
12- 08 - 05